

 utilizing a clock signal used for inputting the print signal, within a period in which the print signal is inputted.--.

REMARKS

Claims 1-52 are pending in this application.

Claims 46-52 have been added to assure Applicants of a full measure of protection of the scope to which they deem themselves entitled. Claims 1, 10 and 17 have been amended to define still more clearly what Applicants regard as their invention.

Claims 1, 10, 17, 28, 38, 46, 51 and 52 are independent.

A Request For Approval Of Drawing Change is submitted herewith, in response to the objection to the drawing.

Applicants note with appreciation the indication that Claims 20-24 would be allowable if rewritten so as not to depend from a rejected claim, and with no change in scope. These claims have not been so rewritten because, for the reasons given below, their base claim is believed to be allowable.

Claims 1 and 10 were rejected under 35 U.S.C. § 102(e) as being anticipated by U.S. Patents 5,781,205 (Silverbrook) and 5,969,730 (Inose et al.), Claims 2, 3, 11

and 12, as being anticipated by *Inose*, and Claims 8 and 9 as being anticipated by *Silverbrook* 205. Claims 4-9, 13-19 and 25-37 were rejected under 35 U.S.C. § 103(a) as being obvious from *Inose*, and Claims 38-45, as being obvious from U.S. Patent 4,542,385 (*Jinnai et al.*).

Independent Claim 1 is directed to a printing head where an electrothermal transducer for generating thermal energy used for discharging ink and a driver for driving said electrothermal transducer are provided on a substrate. According to Claim 1, the printing head comprises a sensor which detects the condition of the substrate and outputs an analog signal, and an A/D converter which converts the analog signal from the sensor into a digital value to be outputted to the outside of the printing head. Also, according to Claim 1, the sensor and the A/D converter are provided on the substrate.

Thus, one important feature of Claim 1 is the outputting of a digital value to the outside of the printing head, by providing an A/D converter which converts an analog signal into the digital value, within the printing head. By virtue of this feature, the information outputted from the printing head can be received by the apparatus main body with high precision without undue interference from various sources of noise.

In a conventional printing head, a detected signal, (for example, a temperature value detected within the printing head) is outputted to the outside of the head as an analog signal and converted into a digital signal within the apparatus main body to be used in the control of the printing head. In such a conventional printing apparatus, however, accuracy of the detection within the head is not required, and therefore, the effects of noise on the analog signal can be tolerated.

However, in high-resolution printing in recent years, the influence of noise cannot be neglected.

The aspect of the invention to which Claim 1 is directed, is based on Applicants' having found that the signal lines between the head and the main body are likely to be influenced by noise. Accordingly, the printing head of Claim 1 is constructed so that the analog signal is converted into a digital signal, which is more robust against the effects of noise.

On the other hand, *Silverbrook 205* relates to a print head having a temperature sensor and AD converter 311 which converts the sensor output into a digital signal. However, Applicants note that, according to *Silverbrook 205*, particularly, Fig. 4 and col. 29, lines 27 and 28, the AD

converter 311 is provided outside of the print head, such as in the microcontroller 315.

As to *Inose*, Applicants note from Fig. 1 and col. 7, lines 13-17, that the A/D converter is also provided outside of the print head, such as in CPU-E 161.

Applicants submit that nothing in either of these patents would teach or suggest providing an A/D converter within a printing head. Applicants also submit that neither the *Silverbrook 205* nor the *Inose* device can prevent the influence of noise on the analog signal outputted from the print head.

Further, Applicants strongly assert that the provision of an A/D converter within a printing head is not merely a matter of design choice, since an unexpected remarkable advantage in which the information outputted from the printing head can be received by the apparatus main body with high precision in spite of the influence of various sources of noise is attained by the feature recited in Claim 1.

At least for the above reason, Claim 1 is deemed to be clearly allowable over both *Silverbrook 205* and *Inose*.

Moreover, Claims 10 and 46 are directed to articles which, as recited, have features to which the foregoing arguments also apply, and hence Claims 10 and 46 also are

deemed to be allowable over those two patents, for the same reasons as is Claim 1.

Independent Claim 17 is directed to a printing head which performs printing by discharging ink in accordance with an ink-jet method, and which comprises a memory for storing information of the printing head, a converter which converts an analog signal into digital signal and outputs the digital signal, and a driver which drives the plurality of printing elements in accordance with an input print signal. Also, according to Claim 17, the information is read from the memory by using a clock signal and a latch signal for inputting the print signal, and the digital signal is outputted from the converter by using the clock signal.

Thus, one important feature of a device according to Claim 17, is outputting information stored in memory and digital data converted by an A/D converter by using a clock signal for inputting the print data. By virtue of this feature, the number of signal lines inputted into the printing head is reduced, and the size of the printing head substrate can be reduced by decreasing the number of connecting pads between the printing head and the apparatus main body.

As a result, use of the structure recited in Claim 17 can reduce the size and cost of the printing head, while

providing high-reliability operation of the printing head by preventing erroneous operation due to noise.

Inose, in contrast, even if it shows using the same clock signal for both transferring print data to a printing head and storing data into the printing head, has not been found to have any description of outputting information or data from the printing head. For at least this reason, Claim 17 is deemed to be clearly allowable over *Inose*.

Independent Claim 28 is directed to a printing head that comprises a nonvolatile memory for storing information about the condition of the head, and output means for outputting that information, in a serial format, to the outside of the head, by utilizing a clock signal and a latch signal used for inputting the print signal, within a period in which the print signal is inputted.

One important feature of a printing head according to Claim 28 is outputting the information stored in a nonvolatile memory in a serial format by using a clock signal used for inputting a print signal, within a period in which the print signal is inputted. By virtue of this feature, even if the amount of information to be transmitted increases, the number of signal lines required does not increase. Therefore, stable head information transfer can be performed.

Accordingly, high-speed printing and fine control utilizing the information transferred from the printing he can be performed. This is an advantage attained by use of the structure recited in Claim 28.

Inose, in contrast, only shows the transfer of print data to a printing head, and Applicants can find no description to suggest that the data transfer occurs within a period in which the print signal is inputted in *Inose*. For at least that reason, Claim 82 is deemed to be clearly allowable over that patent.

Independent Claim 38 is directed to a printing head which outputs temperature information in accordance with the input of print data, and which comprises a shift register that inputs print data in accordance with a first-frequency clock, a heater energized in accordance with the print data, a temperature detector that detects an internal temperature of the head, and a frequency divider, which divides the first frequency to generate a second-frequency clock. Also, according to claim 38, the temperature detector outputs a signal indicative of a detected temperature, in accordance with the second-frequency clock.

One important feature of the structure recited in Claim 38 is generating a second-frequency clock from a first-frequency clock used for inputting print data, and outputting

a signal indicative of detected temperature by using a second-frequency clock. By virtue of this feature, it is not necessary to increase the operation speed of the temperature detector, and the cost that would be involved in such an increase in the operation speed can be avoided. Accordingly, cost-saving printing head temperature control and high-speed print data transfer can be attained.

On the other hand, *Jinnai*, even if it shows a frequency divider for generating a clock signal used for compensation of charged amount, also uses the generated clock signal for data processing within the printing head. Applicants have found nothing in *Jinnai* that would teach or suggest outputting information with a clock which has a different frequency from the frequency used for inputting data.

For at least that reason, Claim 38 is deemed to be clearly allowable over *Jinnai*.

Claims 51 and 52 are method claims directed to features similar to those of Claims 17 and 28, respectively, and are therefore deemed allowable for the same reasons as are the latter claims.

A review of the other art of record has failed to reveal anything which, in Applicants' opinion, would remedy the deficiencies of the art discussed above, as references

against the independent claims herein. Those claims are therefore believed patentable over the art of record.

The other claims in this application are each dependent from one or another of the independent claims discussed above and are therefore believed patentable for the same reasons. Since each dependent claim is also deemed to define an additional aspect of the invention, however, the individual consideration or reconsideration, as the case may be, of the patentability of each on its own merits is respectfully requested.

In view of the foregoing amendments and remarks, Applicants respectfully request favorable reconsideration and early passage to issue of the present application.

Applicants' undersigned attorney may be reached in our New York office by telephone at (212) 218-2100. All

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Respectfully submitted,


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CLAIMS MARKED TO SHOW CHANGES

1. (Amended) A printing head where an electrothermal transducer for generating thermal energy used for discharging ink and a driver for driving said electrothermal transducer are provided on a substrate, comprising:

a sensor which detects the condition of said substrate and outputs an analog signal; and

an A/D converter which converts the analog signal from said sensor into a digital value to be outputted to the outside of said printing head,

wherein said sensor and said A/D converter are provided on said substrate.

10. (Amended) A printing head substrate having a electrothermal transducer for generating thermal energy used for discharging ink and a driver for driving said electrothermal transducer, comprising:

a sensor which detects the condition of said substrate and outputs an analog signal; and

an A/D converter which converts the analog signal from said sensor into a digital value to be outputted to the outside of said printing head,

wherein said sensor and said A/D converter are provided on said substrate.

17. (Amended) A printing head which performs printing by discharging ink in accordance with an ink-jet method, comprising:

a memory for storing [printing characteristics of a plurality of printing elements for discharging ink]
information of said printing head;

a converter which converts an analog signal into digital signal and outputs the digital signal; and

a driver which drives said plurality of printing elements in accordance with an input print signal,

wherein the [printing characteristics are]
information is read from said memory by using a clock signal and a latch signal for inputting said print signal,

and wherein the digital signal is outputted from said converter by using said clock signal.